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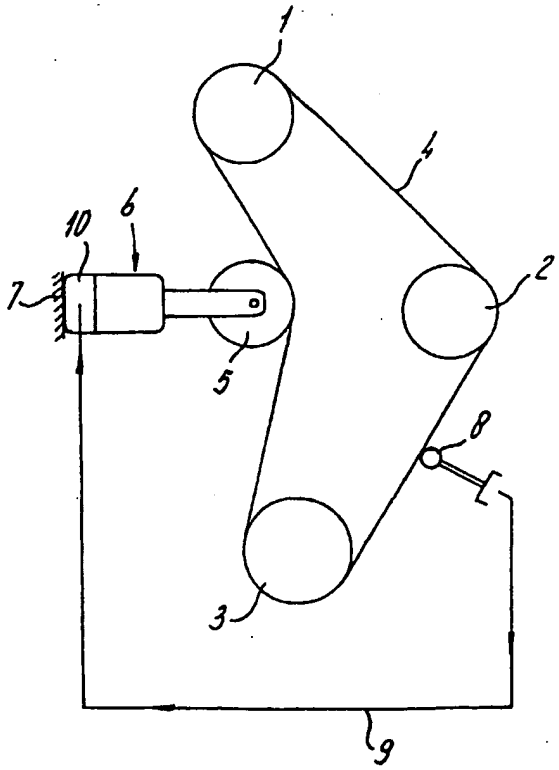
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(54) Title: METHOD FOR CONTROLLING A BELT–PULLEY DRIVE SYSTEM, AND BELT–PULLEY DRIVE SYSTEM

(57) Abstract

A method for controlling the tension in a belt–pulley drive system comprising at least one drive pulley and one driven pulley (1, 2, 3), around which a drive belt (4) is applied under tension, tensioning means (5, 6) for influencing said tension, and control means (10) for controlling the tensioning means (5, 6), comprises the steps of: determining the vibration in the drive system, or a parameter associated with the vibration behaviour thereof, controlling the tension in the drive belt on the basis of said vibrations, or the magnitude of said parameter.



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Method for controlling a belt-pulley drive system, and belt-pulley drive system

The invention is related to the field of belt-pulley drive systems, and in particular to the behaviour thereof under load. Belt pulley drive systems are applied in several fields. As an example, the belt-pulley drive for driving the ancillary equipment of a combustion engine is mentioned, e.g. for driving the dynamo, water pump etcetera.

These drive systems operate within a range of rotational speeds, depending on e.g. the power required from a combustion engine. As a result of these varying operating conditions, vibrations may develop in the belt-pulley drive system. Such vibrations also depend on the tension in the belt, and also the wear conditions of the belt-pulley drive system.

The occurrence of such vibration is undesirable, as they may cause damage to the drive system and may aggravate wear. Furthermore, the noise produced may be unacceptable, e.g. in motor vehicle applications.

The object of the invention is therefore to provide a method for improving the behaviour of such drive system under load. This object is achieved by means of a method for controlling the tension in a belt-pulley drive system comprising at least one drive pulley and one driven pulley, around which a drive belt is applied under tension, tensioning means for influencing said tension, and control means for controlling the tensioning means, said method comprising the steps of:

- determining the vibrations in the drive system, or a parameter associated with the vibration behaviour thereof,

- controlling the tension in the drive belt on the basis of said vibrations, or the magnitude of said parameter.

After determining the vibrations in the drive system, it is possible to influence the belt tension in such a way that the vibrations are reduced or completely suppressed. This has the advantage that a standard pulley-belt drive system still can be used, while at the same time an upgrading of its vibration behaviour is obtained by means of added-on control steps.

Additionally, other phenomena which influence the behaviour of a belt-pulley drive system can be taken into consideration as well. As an example, the undesirable occurrence of slip between the drive belt and the pulleys is mentioned.

Here as well, the invention may be applied in a fruitful way, by applying the steps of

- determining the slip between the drive belt and at least one of the pulleys,
- controlling the tension in the drive belt also on the basis of the magnitude of said slip.

Thus, according to the invention also slip, which contributes to the wear of the belt and pulleys, may be suppressed.

The method according to the invention can be put into practice in several ways. For instance, the method may be used in combination with a monitoring system which detects vibration phenomena, as slip etcetera. The tension is then controlled on the basis of signals which are provided by the monitoring system.

Other practical applications for the method are possible as well. It should be borne in mind that in most cases, identical belt-pulley drive systems are applied in an identical environment, e.g. as ancillary component for a combustion engine. In such cases, according to the invention the method according to the invention can be applied by:

- determining a control procedure for the belt tension in a test belt-pulley drive system,
- establishing a relation between said control procedure and a characteristic of said drive system,
- copying said control procedure in the control means of a nominal belt-pulley drive which system is identical to the test belt-pulley drive system,
- controlling the nominal belt-pulley drive system on the basis of said same characteristic and said control procedure.

According to this variant of the method according to the invention, only one belt-pulley drive system need to be tested, and the subsequent production belt-pulley drive systems are then produced in a standard fashion.

The characteristics to be used in the method according to the invention may for instance comprise the engine speed, vibrations etcetera.

The invention is also related to a belt, wherein the tensioning means comprises an idle roller connected to an actuating means, said actuating being arranged for pressing the idle roller onto a part of the belt between the pulleys.

The tensioning means may for instance comprise an idle roller connected to an actuating means, said actuating being arranged for pressing the idle roller onto a part of the belt between the pulleys.

The invention will now be described further with reference to an embodiment shown in the figure.

The figure shows a belt-pulley drive system, comprising rollers 1, 2, 3, connected by a belt 4. The belt-pulley drive system may e.g. be applied in a combustion engine, for driving the dynamo and/or water pump.

A part of the belt 4 is influenced by a tension wheel 5, which is pressed towards said part of the belt 4 by means of a linear actuator 6. This actuator 6 is connected to a fixed point, e.g. to the engine in question.

Furthermore, a sensor 8 has been applied for a detecting certain phenomena in the belt 4, in particular vibrations. The sensor 8 emits signals which are indicative of those vibrations, which signals by means of cable 9 are transmitted to the control unit 10. The sensor 8 may be integrated in the linear actuator 6.

The control unit 10 influences the linear actuator in such a way that by means of tension wheel 5 the belt tension is influenced so as to remove the vibrations.

The control unit may comprise a memory into which for instance a vibration spectrum of the belt is stored. This provides for a "self learning" capability of the belt-pulley drive system. On the basis of these store data, the control unit automatically will influence the actuator, and thereby the tension wheel and the tensioning belt 4 in such a way, that future negative phenomena, e.g. vibrations, are damped and prevented at an early stage.

Claims

1. Method for controlling the tension in a belt-pulley drive system comprising at least one drive pulley and one driven pulley, around which a drive belt is applied under tension, tensioning means for influencing said tension, and control means for controlling the tensioning means, said method comprising the steps of:

- determining the vibrations in the drive system, or a parameter associated with the vibration behaviour thereof,
- controlling the tension in the drive belt on the basis of said vibrations, or the magnitude of said parameter.

2. Method according to claim 1, comprising the steps of

- determining the slip between the drive belt and at least one of the pulleys,
- controlling the tension in the drive belt also on the basis of the magnitude of said slip.

3. Method according to claim 1 or 2, comprising the steps of:

- determining a control procedure for the belt tension in a test belt-pulley drive system,
- establishing a relation between said control procedure and a characteristic of said drive system,
- copying said control procedure in the control means of a nominal belt-pulley drive which system is identical to the test belt-pulley drive system,
- controlling the nominal belt-pulley drive system on the basis of said same characteristic and said control procedure.

4. Method according to claim 3, wherein the drive system comprises an engine connected to the driven pulley, and the characteristic is the engine speed.

5. Method according to any of the preceding claims, comprising the steps of:

- reducing a vibration spectrum of the drive system,
- controlling the tension in the drive belt on the basis of said recorded vibration spectrum

6. Method according to any of the preceding claims, comprising the steps of:

- storing the vibrations, or a parameter associated therewith, in a memory,

- controlling the tension in the drive belt also on the basis of the stored vibrations or parameter.

7. Method according to any of claims 1-6, wherein the tensioning means comprise an on/off electromagnet providing a rest position and a tensioning position for increasing the drive belt tension.

8. Method according to any of claims 1-6, wherein the tensioning means comprise an actuator, e.g. a screw actuator and a rotational motor, or a linear motor.

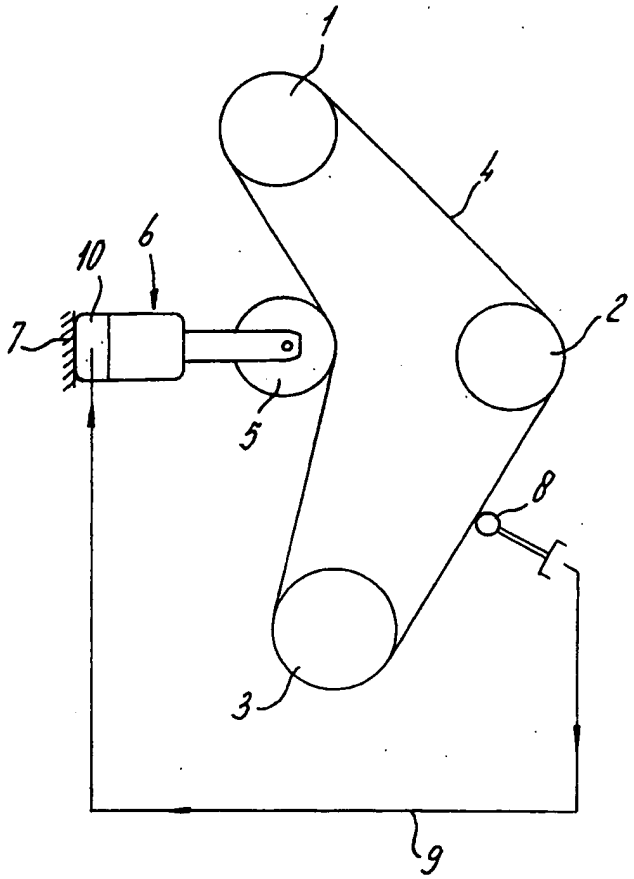
9. Belt-pulley drive system, comprising at least two pulleys around which a drive belt is applied under tension, tensioning means for influencing said tension, control means for controlling the tensioning means, said control means controlling the tensioning means according to the method of any of claims 1-8.

10. Belt-pulley drive system according to claim 9, wherein the tensioning means comprises an idle roller connected to an actuating means, said actuating being arranged for pressing the idle roller onto a part of the belt between the pulleys.

11. Belt-pulley drive system according to claim 10, wherein the actuating means comprises a magnet for displacing the idle roller between an active position in engagement with a part of the belt, and an inactive position.

12. Belt pulley drive system according to claim 10, wherein the actuating means comprise a screw actuator, e.g. a screw actuator and a rotational motor, or a linear motor.

13. Belt-pulley drive system according to claim 6, 7 or 8, wherein the pulleys have a fixed diameter groove.


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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 705 750 A (ECA) 2 December 1994 (1994-12-02)	1
A	abstract; figure 1	5,6,9-13
A	GB 2 219 657 A (LOUGHBOROUGH) 13 December 1989 (1989-12-13) page 2 -page 4	1,5,6, 9-13
A	US 4 478 595 A (NIPPONDENSO) 23 October 1984 (1984-10-23) column 1 -column 4; figure 1	1,7-13
A	US 5 752 891 A (FORD GLOBAL) 19 May 1998 (1998-05-19) abstract; figures 1,3	1,8-13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 699 848 A (NSK) 6 March 1996 (1996-03-06) page 8; figure 7	1,3,9-13

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2705750 A	02-12-1994	NONE	
GB 2219657 A	13-12-1989	WO 9015974 A	27-12-1990
US 4478595 A	23-10-1984	JP 57161344 A	04-10-1982
US 5752891 A	19-05-1998	CA 2171043 A	21-09-1996
		DE 19604182 A	26-09-1996
EP 0699848 A	06-03-1996	JP 8074953 A	19-03-1996
		DE 69506198 D	07-01-1999
		DE 69506198 T	15-04-1999
		KR 180345 B	01-04-1999
		US 5632698 A	27-05-1997